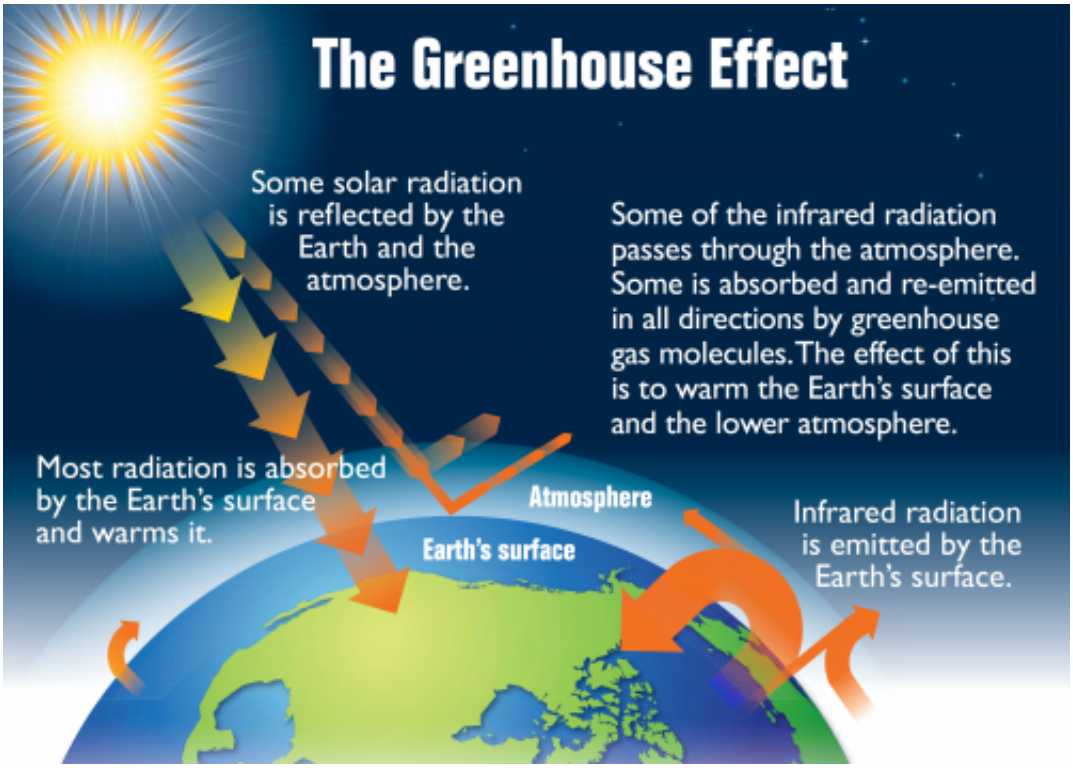
'Punish thy neighbor': Game theory shows the way to control climate change

October 10 2013



Earth's greenhouse effect.

A week ago the UN Intergovernmental Panel on Climate Change (IPCC) delivered to massive media coverage an unsettling message – climate change is real, humans are the main cause of it, and unless we stop the warming of the planet, in 50 years life as we know will be no more. The problem now is that despite innumerous attempts, world consensus on

how to do it has proved impossible to reach. But, with perfect timing, research now out in Nature Climate Change by a Portuguese team, well known for their studies on cooperation, claims to not only to have identified the root of the problem, but also to have a solution. Now, they just need to be listened to.

Vítor Vasconcelos, Francisco Santos and Jorge M. Pacheco from the ATP-group at Lisbon used game theory – a branch of mathematics that studies social interactions – to look into the problem, and found that the key was "scale". Their work showed that cooperation for climate control will only be possible if approached at regional or domestic level, with local institutions sanctioning those that do not collaborate (free-riders). But not just that, as Pacheco, the team leader explains " Our most striking result was to find that punishment by global institutions – which at the present situation would be the most logical choice – is almost like applying no punishment. " The data supports what many believe: that polycentric governance (with many centres of authority) is more effective solving global problems than a central international authority. The findings calls for an urgent revision of the current approaches to climate agreements, and could have not come at a more relevant time with the IPCC now reunited to decide on measures to reach climate change mitigation.

So why are we experiencing global warming?

Despite the media space given to "climate change deniers", there is an overwhelming scientific consensus that the major cause of global warming is an increase of greenhouse gases (such as carbon dioxide and methane) from human action, such as fossil fuel burning, expansion of landfills sites, deforestation, etc. This because earth's temperatures result from, not only the incoming sun energy, but also the "greenhouse effect" (where heat released by earth is absorbed and sent back to the surface by the greenhouse gases in the atmosphere). So as the quantity of

greenhouse gases increase by human action, so the heat absorbed and radiated back to earth, and so global temperatures.

Once this became clear, environmentalists everywhere started asking for a control of greenhouse emissions and in 1998, the Kyoto Protocol, which establishes targets to reduce greenhouse emissions, brought some hope that this could be possible. But 18 meetings and 192 countries' signatures later, still only a handful of nations are following its directives. A clear obstacle is the fact that the risk of climate catastrophe is (wrongly) perceived as low, since it is far in the future.

So how to "force" the world towards climate control?

It is now believed that the solution has to an effective sanctioning/punishing system, capable of deterring those that contemplate escaping their climate control obligations (free-riders)

In the study now published the researchers use game theory, which not only models human strategic interactions, but can also predict the best conditions for a behaviour to emerge (like cooperation towards climate control), to test different types of sanctioning.

In 2011, Pacheco's group had already demonstrated that current approaches – global summits where countries meet in one single group to try achieving an agreement on climate change – were actually detrimental for cooperation. So in the new work they look into using instead local institutions to promote a climate agreement, and test how different types of sanctioning could influence the outcome

So how does game theory work?

The idea is to design a series of mathematical equations that represent

the strategic game we want to test. In this case we have a public good game, where the "public good" (a global good from which everyone benefits, whether they contribute for it or not) is the welfare of the planet, and the aim is to find the conditions necessary to make the players cooperate protecting the planet. A catch is that cooperation is not to gain something, but to avoid the risk of collective loss (catastrophic climate change) making an agreement harder to achieve.

There also two extra obstacles: first the fact that players see the risk of climate disaster as low, and second that the game only has a positive outcome if most players curb enough emissions otherwise everyone will lose. And the problem is that nobody knows what others will do, so it is not clear how much is enough. This, together with cooperation implying sacrifices, makes the chances of free-riders appear very high (like the Kyoto agreement's results so well demonstrate).

Like in any game, there are players and they can be either be co-operators (C) or defectors/non-co-operators (D), but since the Portuguese wanted to test the effect of sanctioning, they added punishers (or P), who are co-operators that contribute also for a sanctioning institution. Like in real life, the players can adapt their behaviour (from being a C to a D for example), as they see what others are doing.

Their results showed that cooperation grows with risk perception. Since in climate change the risk is perceived as low, no surprise that a global agreement has not been achieved.

The good news is that this dynamic changes radically once sanctioning by local institutions is introduced. In this case, cooperation is possible even when the risk is seen as low. Surprisingly, punishment by a global institution gives a pattern of cooperation similar to that found if there is no sanctioning (which is directly dependent of risk size).

This last result is particularly important because it is not an intuitive one (a global sanctioning institution is as effective as do nothing?) and chances are that the IPCC, in its next report in April, will recommend global sanctions mediated by a central international institution, which, according to these results, will not work.

So why are local institutions so much more efficient cooperating even at low risk perception? Vasconcelo's study found a variety of reasons – local sanctioning institutions tend to last longer (promoting cooperation) than global ones, and are easier to emerge acting as catalysers of collective action while stopping free-riders.

The frequency that the individuals change behaviour (from cooperating to become free-riders for example), and which is know to increase the chance of cooperation, is also higher in local institutions probably because these have shorter-term goals allowing players to reassess their choices frequently.

Finally they show that there has to be a minimum number of punishers (co-operators that co contribute to the sanctioning institution) to trigger cooperation in a population, and with many local groups (instead of a global one) there is a bigger chance that at least some will manage it (in smaller populations a smaller number of punishers is needed).

Vasconcelos and Pacheco's work supports what the Economics Nobel prize Elinor "Lin" Ostrom first proposed- that the resolution of climate change lies in polycentric governance; a governance coordinated at many different levels more effective than a international "top-down" approach (like the one we now have).

After all, if climate change has different effects at multiple levels and regions, governance by the groups directly affected has to have the higher chance of success.

And there are already a few successful examples - one of the best-known is the launch, in the 70s, by several US local governments of measures to reduce air pollution (including greenhouse gases). A 2001 study of 51 of their metropolitan areas, showed that, in under 20 years, air pollution was diminished by a third. Other successful example is a program, in Berkley California, that subsidizes the installation of solar panels in homes and businesses and that has been hugely successful.

More information: Vasconcelos, V., Stantos, F. and Pacheco, J. A bottom-up institutional approach to cooperative governance of risky commons, *Nature Climate Change* 3, 797–801 (September 2013). DOI: 10.1038/nclimate1927

Provided by Ciencia Viva

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